

Amendments to the Claims

This list of claims will replace all prior versions and listings of claims in this application.

Listing of Claims

Claim 1. (Currently Amended) A position and force control device comprising:

(i) ~~position detection means for detecting a position of an object; driving means for driving an object based on a driving signal applied thereto;~~

(ii) ~~driving means for driving the object; position detection means for detecting the position of the object to output a position signal;~~

(iii) reaction force detection means for estimating a reaction force which the object receives, where the reaction force is ~~detected indirectly~~ calculated based on a the detected position signal outputted from the position detection means and a the driving signal applied to the driving means ~~and where frictional force and inertial variation on the object are subtracted as known values;~~ and

(iv) control means for calculating a first acceleration signal from the reaction force calculated by the reaction force detection means ~~which the object undergoes~~ and a goal force signal, and further calculating a second acceleration signal from the position signal and a goal position, and outputting a ~~generated driving signal to said driving means, the generated driving signal being~~ an acceleration control signal based on said first and second acceleration signals to said driving means.

Claim 2. (Currently Amended) A position and force control device for controlling a position of an object and force on the object in response to a position command signal signals and a force command signal signals, comprising:

(i) driving means for driving the object based on a driving signal applied

thereto;

(ii) position detection means for detecting a the position of the object to output a position signal;

(iii) reaction force detection means for estimating a reaction force undergone by the object, where the reaction force is ~~detected indirectly~~ calculated based on a the position signal outputted from the position detection means and a the driving signal applied to the driving means ~~and where frictional force and inertia variation on the object are subtracted as known values;~~

(iv) first calculation means for calculating a first difference between a the position command signal and a the position signal outputted by the position detection means and converting the first difference to a first acceleration signal;

(v) second calculation means for calculating a second difference between the reaction force detected calculated by the reaction force detection means and a the force command signal, and converting the second difference to a second acceleration signal; and

(vi) control means for adding the said first and second acceleration signals and outputting a ~~generated driving signal to the driving means, the generated driving signal being an~~ acceleration control signal based on said first and second acceleration signals, to said driving means.

Claim 3. (Currently Amended) A position and force control device for controlling positions of an object on a slave side and of an operation part on a master side in response to a position difference between the operation part on the master side and the object on the slave side, and driving to drive the object with driving force in response to an operation force on the master side, and ~~transmit~~ further transmitting a reaction force on the slave side to the master side,

comprising:

- (i) first driving means for driving the operation part on the master side based on a first driving signal applied thereto;
- (ii) first position detection means for detecting a first position of the operation part on the master side to output a first position signal;
- (iii) first reaction force detection means for estimating a first reaction force acted acting on the operation part to output a first estimated value, where the first reaction force is ~~indirectly detected~~ calculated based on a the first position signal outputted from the first position detection means and a the first driving signal applied to the first driving means;
- (iv) second driving means for driving the object on the slave side based on a second driving signal applied thereto;
- (v) second position detection means for detecting a second position of the object on the slave side to output a second position signal;
- (vi) second reaction force detection means for estimating a second reaction force undergone by the object to output a second estimated value, where the second reaction force is ~~indirectly detected~~ calculated based on a the second position signal outputted from the second position detection means and a the second driving signal applied to the second driving means;
- (vii) first calculation means for calculating a difference between the first position signal outputted by the first position detection means and the second position signal outputted by the second position detection means, and converting the difference to a first acceleration signal and a second acceleration signal ~~control signals for controlling the master side and the slave side~~;

(viii) second calculation means for calculating a sum of ~~outputs of the first~~ estimated value and the second estimated value respectively outputted from the first and the second reaction force detection means, and converting the sum to a third acceleration signal and a fourth acceleration signal ~~control signals for controlling the master side and the slave side;~~

(ix) first addition means for adding the first acceleration signal and the third acceleration signal ~~control signals~~ to output a first added value;

(x) second addition means for adding the second acceleration signal and the fourth acceleration signal ~~control signals~~ to output a second added value;

(xi) first control means for outputting a first generated ~~driving~~ acceleration control signal to the ~~operation part~~ first driving means on the master side, based on the first added value ~~an output of~~ outputted from the first addition means; and

(xii) second control means for outputting a second generated ~~driving~~ accelerated control signal to the ~~object~~ second driving means on the slave side, based on the second added value ~~an output of~~ outputted from the second addition means.

Claim 4. (Currently Amended) The position and force control device of claim 1 wherein the reaction force detection means comprises at least two reaction force estimation observers, wherein the reaction force estimation observers ~~indirectly sense~~ calculate reaction forces based on the driving signal and the position signal.

Claim 5. (Currently Amended) The position and force control device of claim 2 wherein the reaction force detection means comprises at least two reaction force estimation observers, wherein the reaction force estimation observers ~~indirectly sense~~ calculate reaction forces based on the driving signal and the position signal.

Claim 6. (Currently Amended) The position and force control device of claim 3 wherein the first and second reaction force detection means each comprise a force estimation observer ~~that indirectly senses~~ calculates reaction forces based on the first driving signal and the first position signal or the second driving signal and the second position signal respectively.

Claim 7. (New) The position and force control device of claim 2, wherein the reaction force detection means subtracts both frictional force and inertia variation's force on the object, respectively as known values, when the reaction force is calculated.

Claim 8. (New) The position and force control device of claim 2, wherein the reaction force detection means subtracts both frictional force and inertia variation's force on the object, respectively as known values, when the reaction force is calculated.

Claim 9. (New) The position and force control device of claim 3, wherein the first reaction force detection means subtracts both frictional force and inertia variation's force on the operation part on the master side, respectively as known values, when the first reaction force is calculated, and the second reaction force detection means subtracts both frictional force and inertia variation's force on the object on the slave side, respectively as known values, when the second reaction force is calculated.